

SD Update

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The typical U.S. Army helicopter SD accident is **LESS** one of classical vestibular or visual illusions giving a pilot vertigo, but **MORE** one of **hard-pressed aircrew, flying a systems intensive aircraft under NVD, failing to detect a dangerous flight path.**

What are the factors
that contribute to SD
accidents?



The Nature of Rotary Wing SD

- Wide ranging
- Well known causes infrequent or absent
- Distraction
- Poor visual cues
- Inadequacies of NVDs
- ? Poor awareness of SD

Aircrew Factors

- Experience
- Currency (competency?)
- Work/Sleep
- Sex
- Medical waivers/Drugs

What do we need to
know ?

How will it help?

Why do we not know?

What we need to know

- More detailed information about the incidence and causation of SD Accidents
- Consistent, reliable reporting to enable comparisons to be drawn between:
 - aircraft types
 - services
 - national practices

How will it help?

- Accurate epidemiology will allow targeting of research and training resources
- Comparisons will highlight good practices and assist in dissemination
- Comparisons between aircraft types will assist in identifying to commanders and leaders where problems exist

Disparity of Reporting

- Differing opinions
- Differing training
 - Leads to different patterns of reporting of SD in accidents between nations, services and even individual flight surgeons
- Does this matter greatly?

YES!!

- Without consistent reporting the analysis of the problem of SD is skewed from the outset
- Example:
 - failure to recognise SD involvement in a series of night accidents may lead to a conclusion that more training is needed, without addressing the disorientation from an HMD, leading to more accidents!

THE SD ANNEX

- WP61 of ASCC (Air Standardization Co-ordinating Committee) SD project group has agreed the SD Annex as a “universal” tool.
- Aim of Annex is to assist in the definition of SD accidents and routine collection of data

SPATIAL DISORIENTATION (SD) ACCIDENT OR INCIDENT ANNEX

Mishap or incident Identification

*Please ensure that this accident annex is "linked" to the accident
(procedure to be determined locally).*

Type and model of aircraft

Use the following definitions for completion of this annex.

Spatial disorientation

.... a term used to describe a variety of incidents occurring in flight where the pilot fails to sense correctly the position, motion or attitude of the aircraft or of himself within the fixed co-ordinate system provided by the surface of the earth and the gravitational vertical. In addition, errors in perception by the pilot of his position, motion or attitude with respect to his aircraft, or of his own aircraft relative to other aircraft, may also be embraced within a broader definition of spatial disorientation in flight.....

Contact with an obstacle known to be present - but erroneously judged to be sufficiently separated from the aircraft is to be included as spatial disorientation. Contact with an obstacle whose presence was simply unknown is not considered spatial disorientation, unless it is associated with other manifestations.

It is stressed that although SD is a subset of overall SITUATION AWARENESS (SA), the broader aspects of SA are not considered in this annex, e.g., "Geographic disorientation" (or getting lost) would be excluded.

**USE THE SPACE BELOW EACH QUESTION FOR COMMENTS
(or continue on a blank sheet quoting the question number)**

Question 1. Was Spatial Disorientation clearly **NOT** a factor in this mishap or incident?
(Circle one)

- a. SD could have been a factor.
- b. SD was clearly **NOT** a factor. **(If circled, stop here)**

Question 2. Was more than one aircrew member or aircraft involved in mishap or incident?
(Circle one)

- a. Yes (complete a separate SD annex for each aircrew member who experienced SD, or contributed to the mishap).
Please ensure that this accident annex is “linked” to the accident (procedure to be determined locally).
- b. No

Question 3. What was the role of Spatial Disorientation in this mishap or incident? (see definitions)
(Circle one **ONLY**)

- a. The **major** factor in this mishap or incident
(All other contributory factors would normally have been overcome without mishap.)
- b. A **contributory** factor leading up to this mishap or incident
(Other contributory factors would have led to a mishap, but SD made the accident sequence more difficult to deal with or the outcome more severe.)
- c. Only an **incidental** occurrence to this mishap or incident
(SD occurred but did not affect the outcome.)

Why should I?

- Complete Annex is 27 pages(!) - but many pages are simple “circle the answer”
- Not as daunting as it may seem
- Provides a standard for investigation - you will not be caught out by later questions
- Inputs the information from the Flight Surgeon **who is there** into the research process - reverse the “Garbage in Garbage out” problem!

Is it official policy?

- It is not a requirement for US services (yet)
- The information is to be sent to single Service Safety Centers - no breach of Service interest or security
- There is no obligation on the Safety Centers to process the data, just store it (it would be good if they were able and interested though!)

How do I get “Annexed”

- Available in hard copy and by email
- If accepted may be on next CD-ROM
- Email:
 - philip.johnson@semail.amedd.army.mil
- Hard copy:
 - Limited number at the back
 - Lt. Col. Phil Johnson
 - USAARL, Ft. Rucker, AL, 36363-0577

Evaluation of a
Standardized Spatial
Disorientation
Flight Profile

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And

Patricia A. Leduc

Introduction

- The primary purpose of this investigation was to establish a standardized simulator flight profile that could be used to collect and analyze flight performance measures during tests of pilot response to disorientating events.

Background

- Braithwaite et al. (1997) reported that SD was a major or contributory factor in 30 percent of all class A through C accidents.
- During the period 1987-1995, 36% of SD accidents were class A compared to 18% of non-SD accidents.
- The average cost of an SD accident was more than double (1.62 million) that of a non-SD accident (0.74 million) as was the loss of life (0.38 vs. 0.14).

Methods

- The USAARL NUH-60 Blackhawk simulator has a computer software package which allows the production of divergent visual and motion cues.
- These visual-vestibular mismatches result in disorientation as pilots are unable to correctly relate their sensation of position, motion and aircraft attitude.

Methods

- A one hour flight profile incorporated various mismatch events among standard maneuvers over varying terrain such as water, mountains, and forest.
- Flight recovery was defined as the point in time at which a pilot returned to the heading, altitude, and airspeed being flown immediately prior to the event.

Methods

- This one hour profile contained repeated measures of standard flight maneuvers that included straight and level flight, standard rate turns, hovers, and descents and three visual-vestibular mismatches designed to produced disorientation.
- Subjective and objective measures of flight parameter recovery following the visual-vestibular mismatches and symptoms of simulator sickness produced by this flight profile were examined.

Methods

- Twenty-one UH-60 qualified aviators flew a 1 hour profile during which three mismatch events occurred.
- All flights were flown under simulated dusk conditions regardless of the actual time of day.

Methods

- Aviators were then asked to rate each event in terms of difficulty of flight recovery by marking along three, 100mm lines (1 for each event) anchored by the phrases “extremely easy” and “extremely difficult”.
- Each aviator also provided information such as his/her total number of UH-60 hours (aircraft and simulator).
- Following each flight, the aviator was asked to fill out a simulator sickness questionnaire (SSQ).

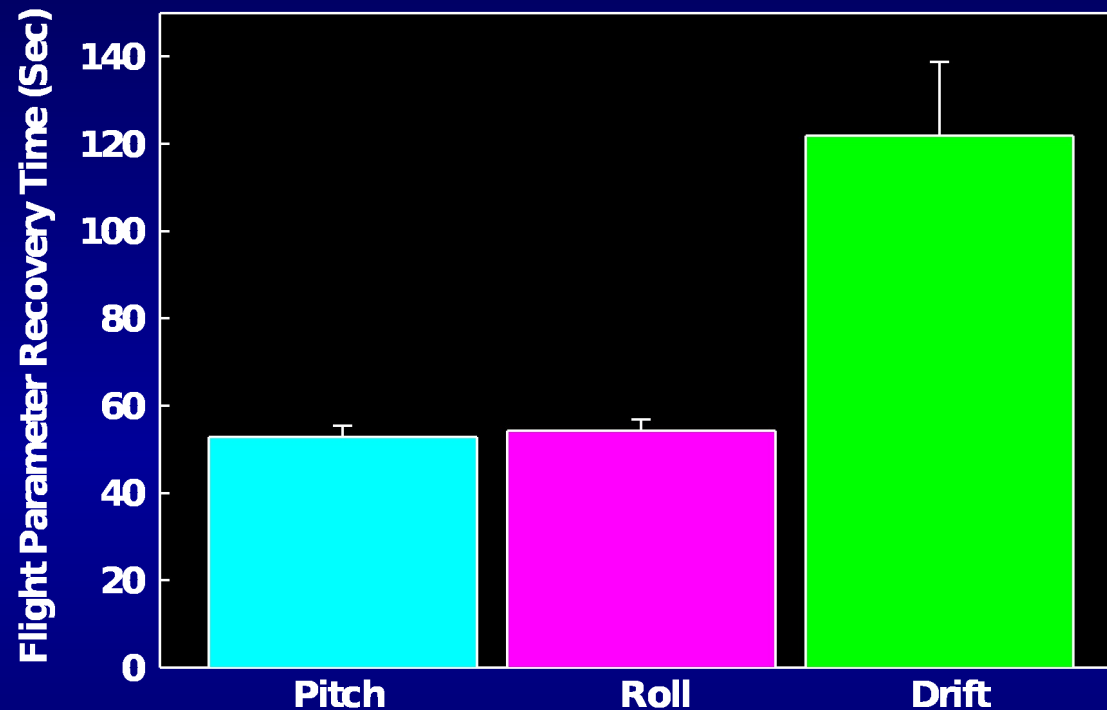
Mismatch events

- Pitch - visuals moved up and motion down at a 4° per/sec divergence. This event occurred during low level flight and gave the impression that the aircraft was nosing into the ground.
- Roll - visuals moved right and motion went left at a 6° per/sec divergence. This event occurred over hilly terrain and gave the impression that the aircraft was rolling right, into a hill.
- Drift - visuals moved left and motion moved right at an 8° per/sec divergence causing an apparent aircraft drift. This event occurred 10 feet above a landing site.

Flight Profile

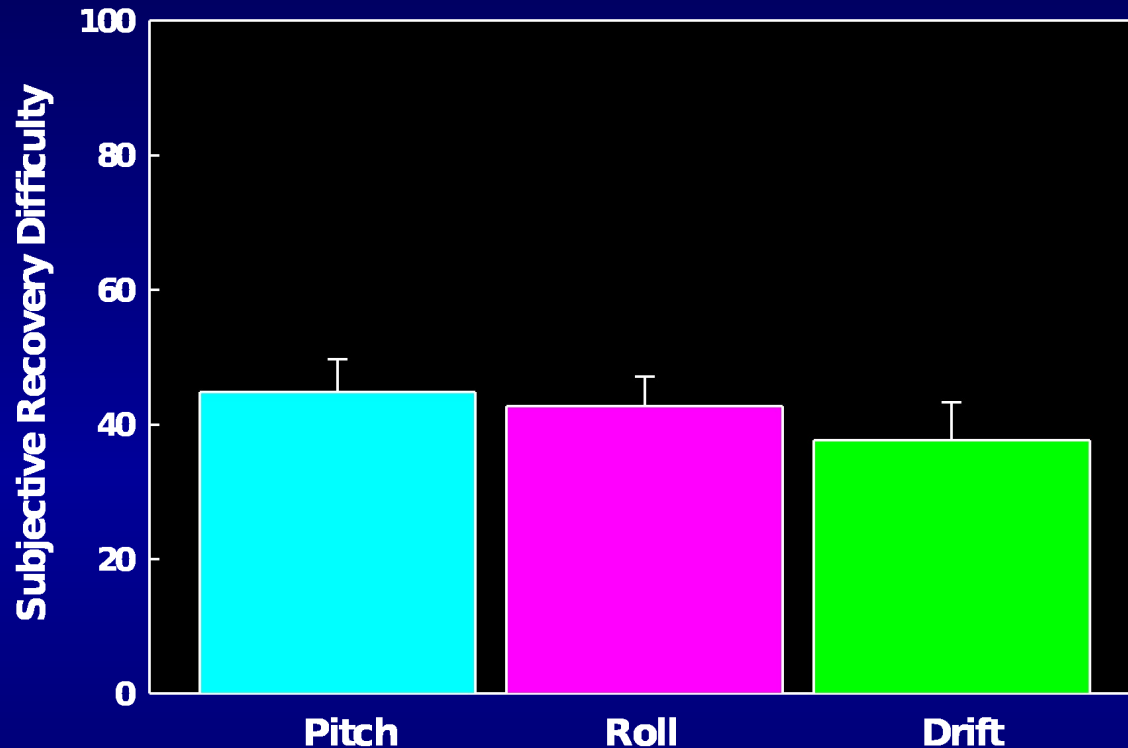
	Description	Time (Sec)	Heading (Deg)	Attitude (Ft)	Airspeed (KIAS)
1	HOV	60	090	10'AGL	0
2	HVRT	60	090>090	10'AGL	0
3	LL CP	240	086	700'MSL	120
4	CLIMB	60	100	700>1200'MSL	120
5	RSRT	60	100>280	1200'MSL	120
6	S/L	60	280	1200'MSL	120
7	RSRT/DESC	60	280>100	1200>700'MSL	120
8	NOE CP	180	344	25'AGL	120
9	CONT CP	180	031	80'AGL	120
10	LAND	120	015	N/A	N/A
11	NOE CP	240	338	25'AGL	120
12	CONT CP	120	296	80'AGL	120
13	LAND	120	255	N/A	120
14	CONT CP	240	319	80'AGL	120
15	CONT CP	120	250	80'AGL	120
16	CLIMB	60	200	1000>1500'MSL	120
17	LSRT	60	200>020	1500'MSL	120
18	S/L	60	020	1500'MSL	120
19	LSRT/DESC	60	020>200	1500>1000'MSL	120
20	CONT CP	180	173	80'AGL	120
21	LAND	120	215	N/A	N/A
22	CONT CP	240	066	80'AGL	120
23	CONT CP	120	076	80'AGL	120
24	CONT CP	120	181	80'AGL	120
25	CONT CP	240	214	80'AGL	120
26	LAND	120	180	N/A	N/A
27	NOE CP	240	249	25'AGL	120

Results



It took aviators significantly longer to recovery from the drift than from either the pitch or the roll ($F(2,38)=203.55$, $p<.001$). Recovery time was approximately 54 seconds for the pitch and roll but more than twice as long for the drift (122 seconds).

Results

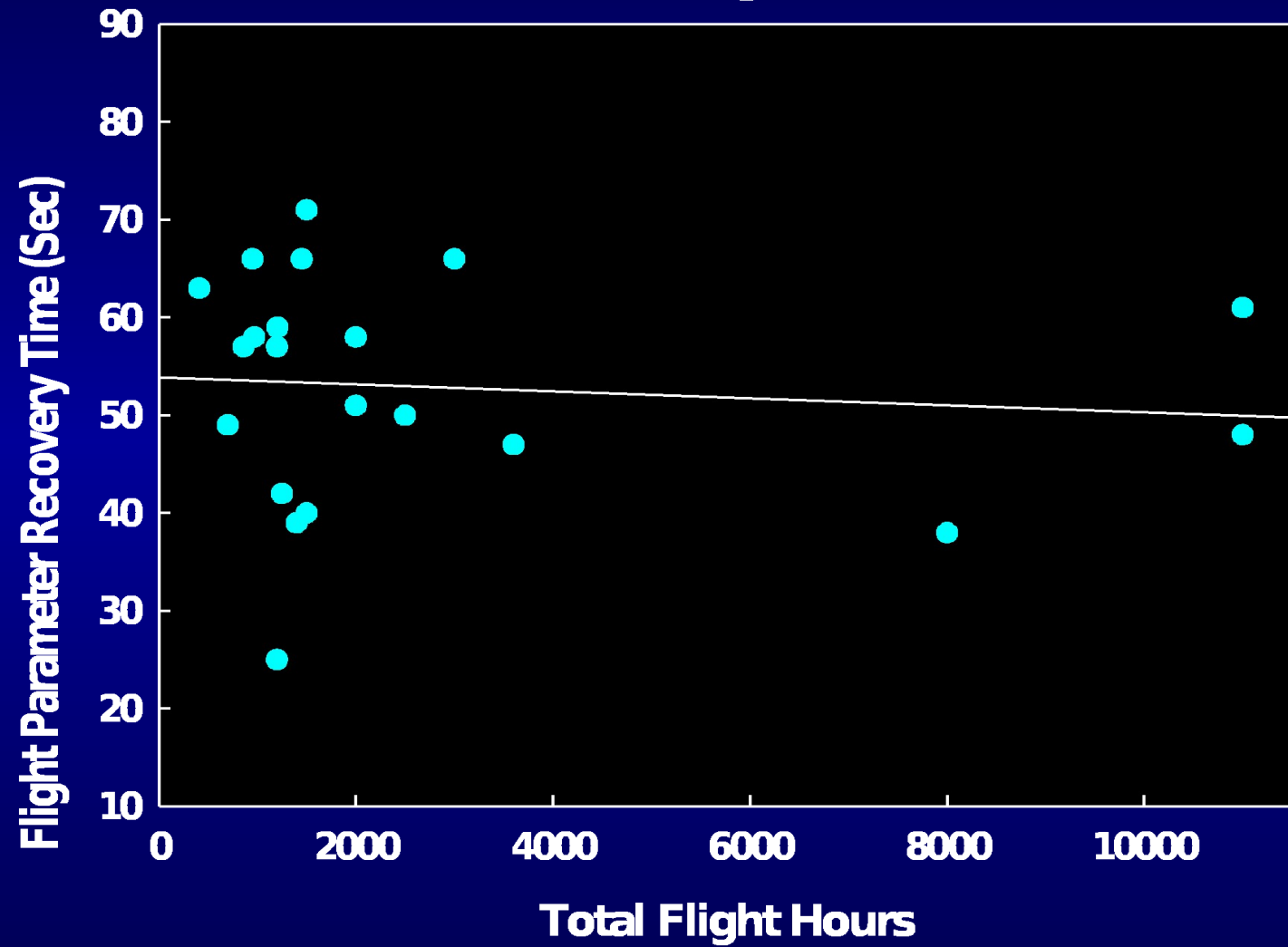


Analysis of the pilot's self-ratings of difficulty of flight recovery following each event showed that aviators considered all three of the events equally challenging to recover from.

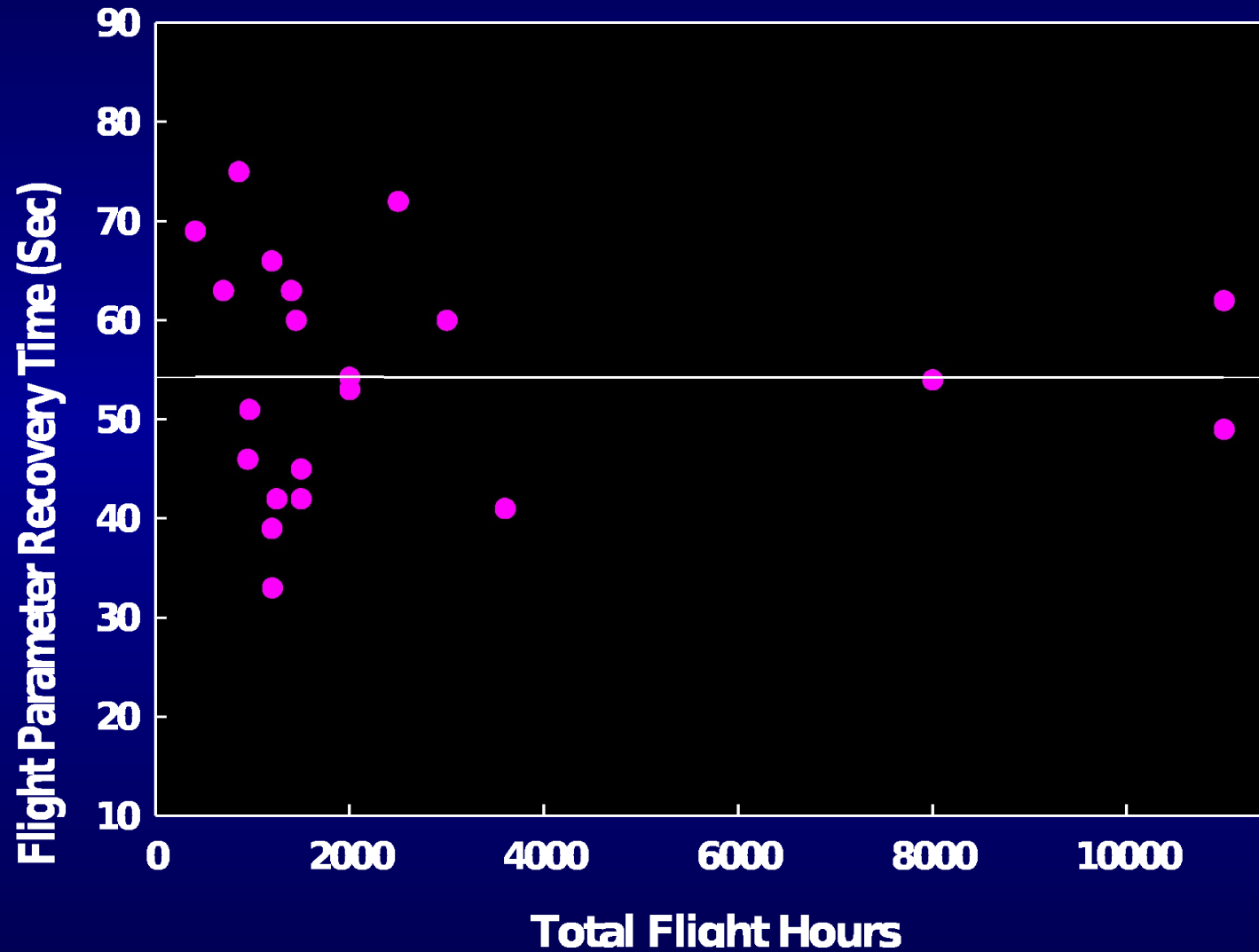
Results

- **Correlations between the aviators' total flight time and recovery times for the events showed a complete lack of relationship (Pitch, $R=.098$, $p=.67$; Roll $R=.0001$, $p=.99$; Drift, $R=.12$, $p=.60$).**
- **The graphs on the next slide illustrate that the regression lines are almost completely flat with slopes near zero.**

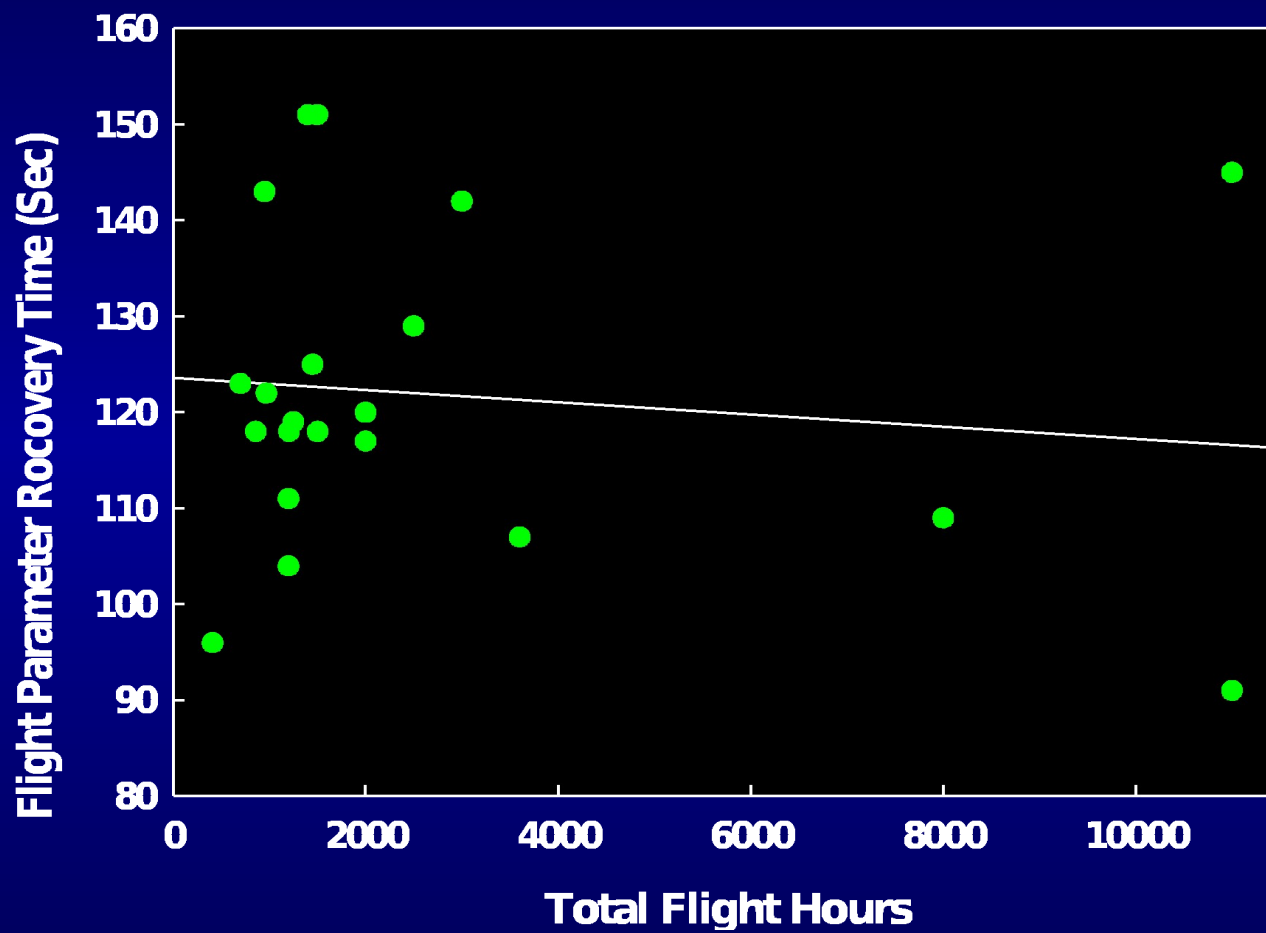
Pitch



Roll



Drift



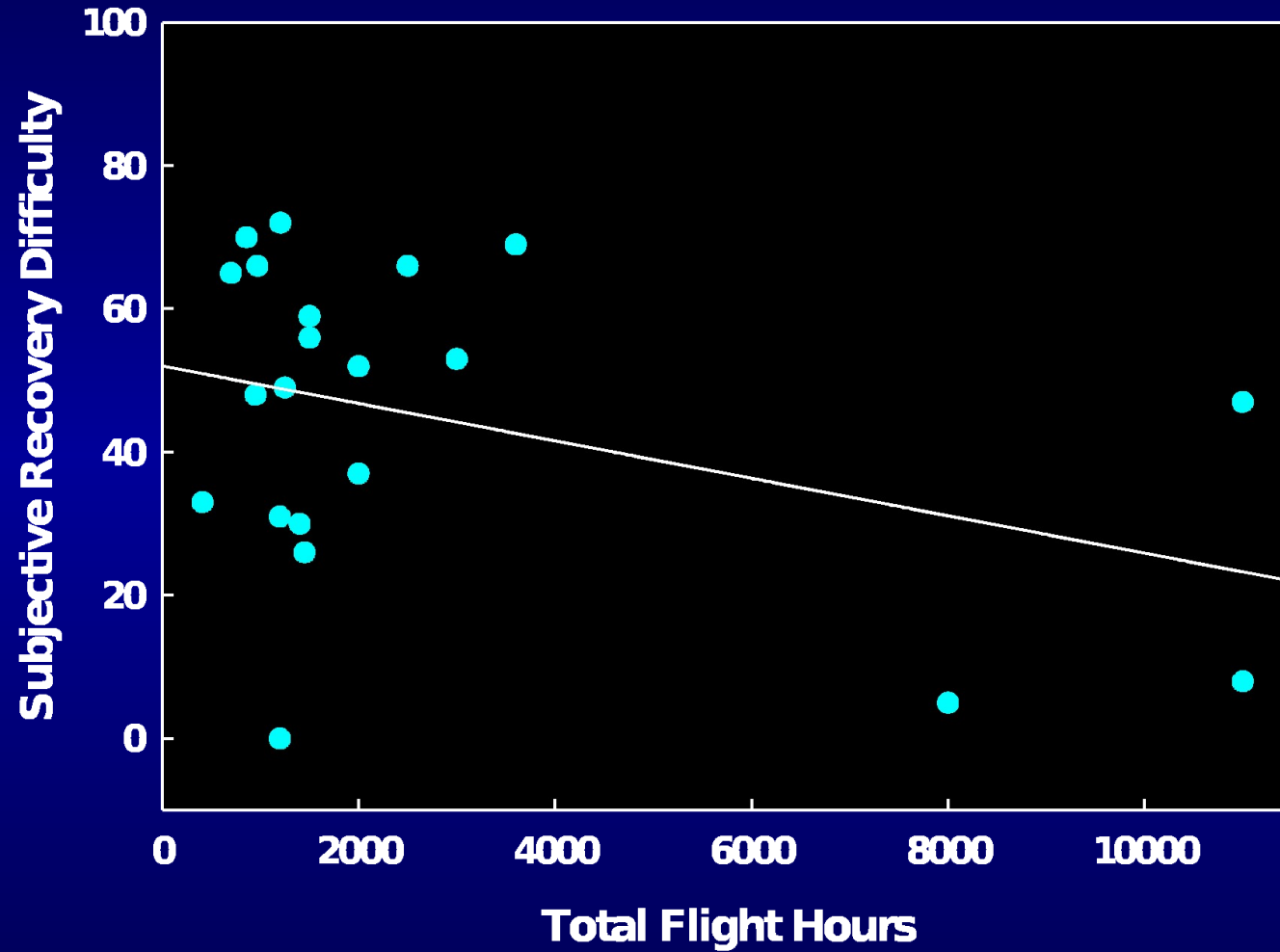
Results

- **Correlations between the aviators' total flight time and the subjective responses to the events showed no relationship between the measures on the roll or drift (Roll, $R=.19$, $p=.41$; Drift, $R=.09$, $p=.69$).**

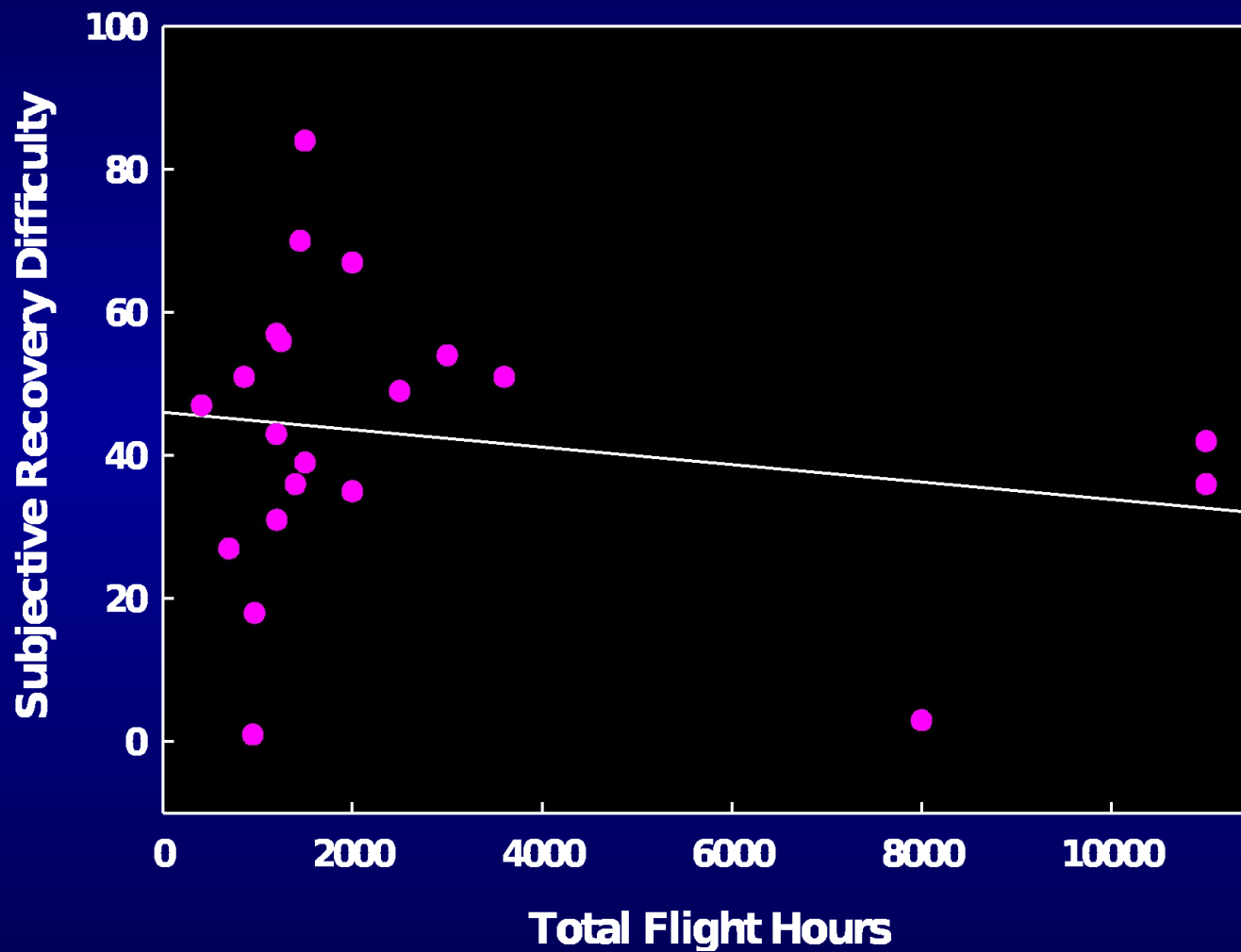
Results

- **A slight but non-significant ($R=.38$, $p=.09$) negative correlation was seen in response to the pitch event. High time aviators reported lower difficulty levels when recovering from this event than lower time pilots.**

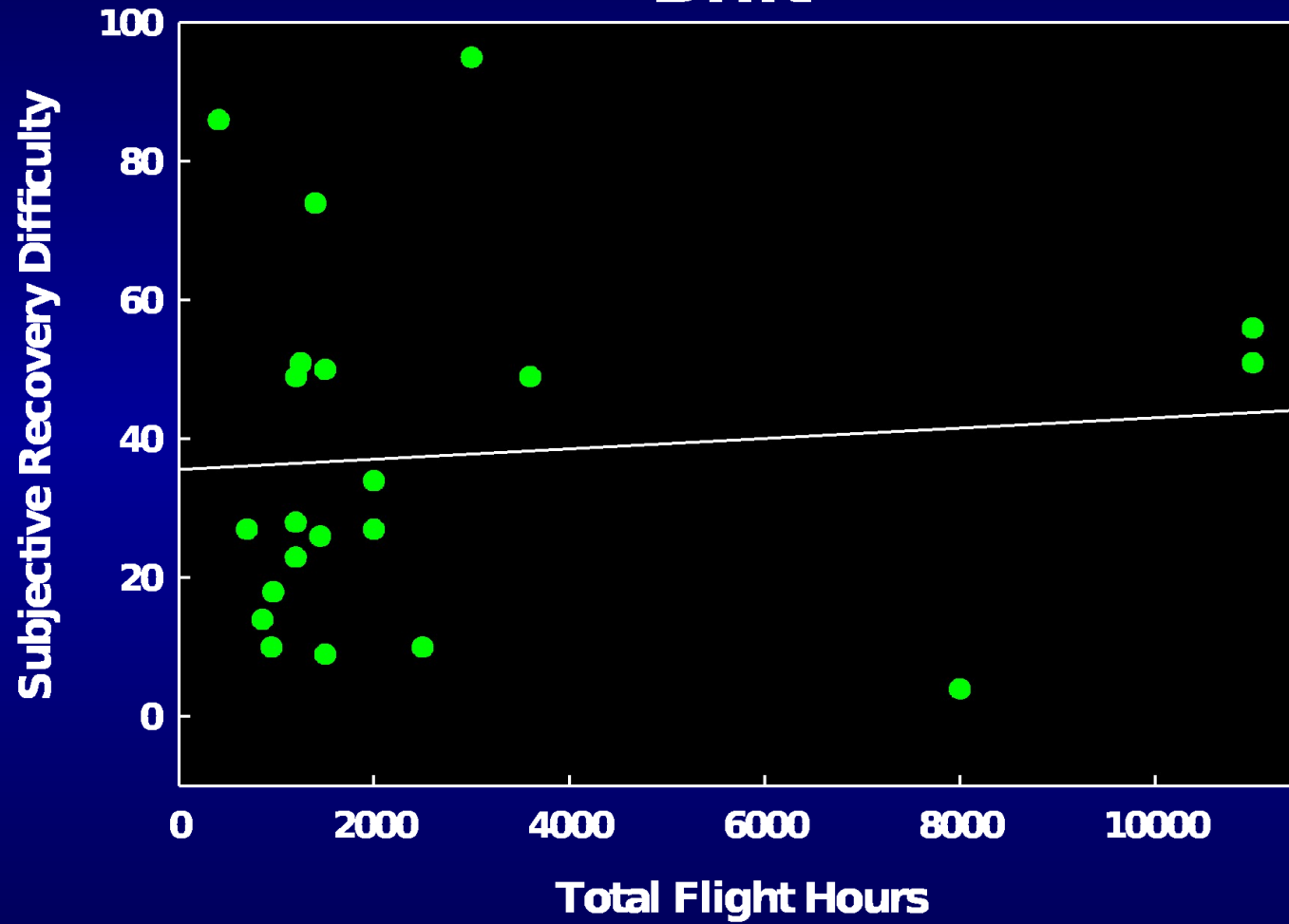
Pitch



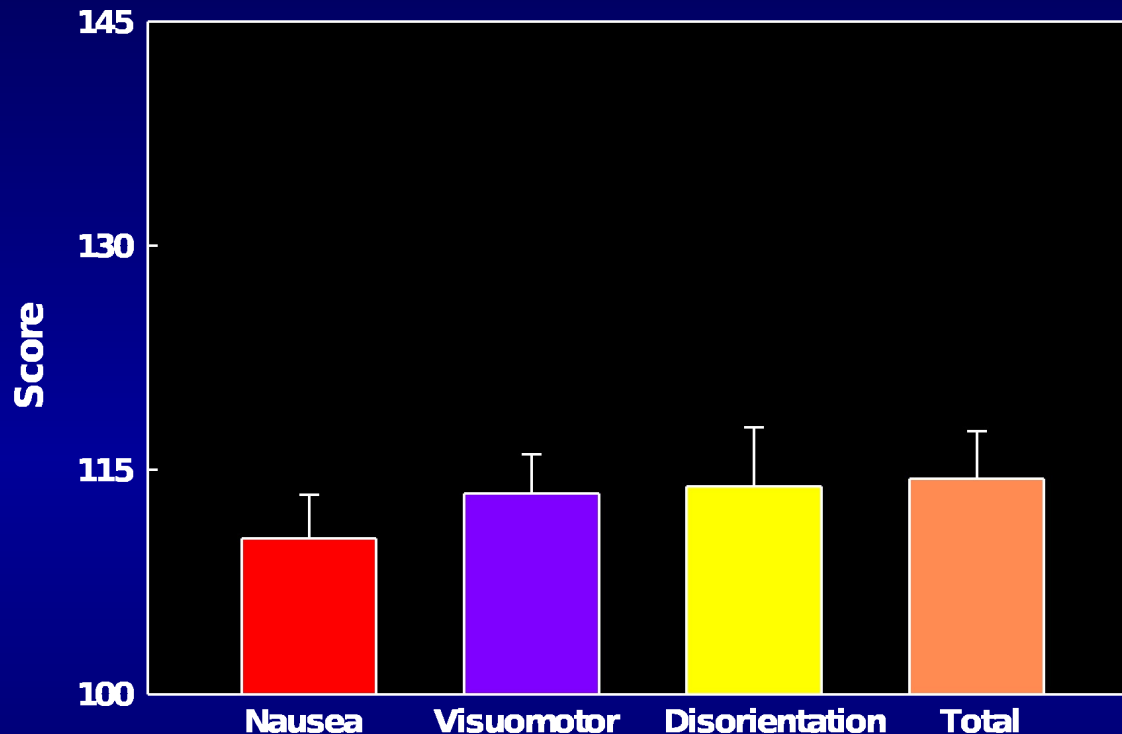
Roll



Drift



Results



For all scales, a score of 100 indicates a total absence of sickness. Analysis of the SSQ data showed that this flight profile did not induce symptoms of simulator sickness(100 to 115 would be considered none to very mild).

Summary

- The rates of visual and vestibular divergence were not severe enough to produce aircraft crashes
- The 3 mismatch events all produced some interference with pilot performance as seen in flight parameter recovery data. The drift event produced the largest impact on recovery time.
- Recovery times following the events were not significantly different between experience groups, indicating neither experience nor inexperience bestow inherent advantage when recovering from these events.

Why do we care?

- This flight profile can be used to allow closer examination of aviator response to in-flight disorientating events without putting the aviators at risk.
- The next study will examine the possible impact that fatigue may have on susceptibility to SD.
- We believe that this is a useable, repeatable tool to investigate the effect of other variables on SD